AI Planning
Exercise Sheet 12

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Exercise 12.1

Let $s_{(o_i,...,o_j)}$ denote a state that is backward reachable from γ by successively following the ordered list of operators $(o_i, ..., o_j)$.
$D_0^{bwd} := \{\gamma\}$ //per definition
$D_1^{bwd} := \{\gamma, s_{(o_1)}\}$ //a is precondition, b is an effect in any case
$D_2^{bwd} := \{\gamma, s_{(o_1)}, s_{(o_1,o_2)}\}$ // a is an effect in any case
$D_3^{bwd} := \{\gamma, s_{(o_1)}, s_{(o_1,o_2)}, s_{(o_1,o_2,o_3)}\}$ //$\neg a \wedge b$ is an effect in any case
$\delta_G^{bwd}(I') = \delta_G^{bwd}(s_{(o_1,o_2,o_3)}) = 3$

Exercise 12.2

Definitions:
$img_o(s) = \{s' \in S \mid s \xrightarrow{o} s'\}$
$wpreimg_o(T) = \bigcup_{s \in T}\{s \in S \mid s \xrightarrow{o} s'\}$
$spreimg_o(T) = \{s \in S \mid \exists s' \in T : s \xrightarrow{o} s' \wedge img_o(s) \subseteq T\}$

The definition of a weak preimage can be reformulated as follows:
$wpreimg_o(T) = \{s \in S \mid \exists s' \in T : s \xrightarrow{o} s'\}$

Since in the given transition system an operator leads from a state in which it is applicaple to *exactly one* state we can further reformulate:
$wpreimg_o(T) = \{s \in S \mid s \xrightarrow{o} s'\}$

For the strong preimage, performing the same step we get:
$spreimg_o(T) = \{s \in S \mid s \xrightarrow{o} s' \wedge img_o(s) \subseteq T\}$

Again, since there is only one state an operator can lead to from a given state, $s \xrightarrow{o} s'$ implies $img_o(s) \subseteq T$. We therefore get:

$$\begin{aligned} spreimg_o(T) &= \{s \in S \mid s \xrightarrow{o} s' \wedge \top\} \\ &= \{s \in S \mid s \xrightarrow{o} s'\} \\ &= wpreimg_o(T) \end{aligned}$$

Exercise 12.3

(a)

Nondeterministic planning task: $\Pi = \langle V, I, O, \gamma \rangle$, where

$V = \{L_1, L_2, R_1, R_2\}$, $\mathscr{D}_{v \in V} = \{e, x, y\}$
$I = \{L_1 \to e, L_2 \to e, R_1 \to e, R_2 \to e\}$
$O = \{o_L, o_R\}$
$\gamma = \{(L_1 = x \wedge L_2 = x) \vee (R_1 = x \wedge R_2 = x) \vee (L_1 = x \wedge R_1 = x) \vee (L_2 = x \wedge R_2 = x) \vee (L_1 = x \wedge R2 = x) \vee (L_2 = x \wedge R_1 = x)\}$, where

$o_L = \langle L_1 = e \vee L_2 = e, (L_1 = e \to L_1 = x) \wedge (\neg L_1 = e \to L_2 = x) \rangle$
$o_R = \langle R_1 = e \vee R_2 = e, (R_1 = e \to R_1 = x) \wedge (\neg R_1 = e \to R_2 = x) \rangle$

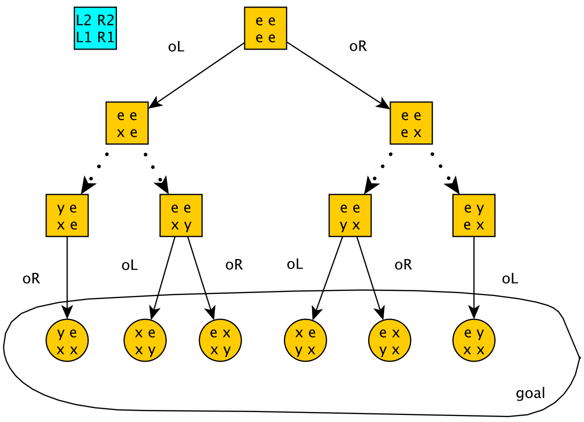

Figure 1: Nondeterministic Transition Graph for 2x2 TicTacToe

(b)

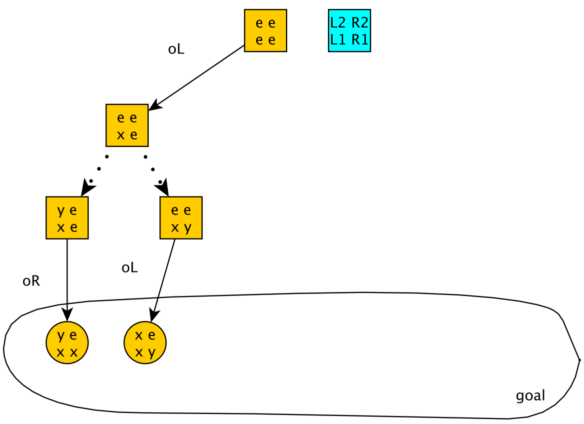

Figure 2: SolutionGraph for 2x2 TicTacToe provided by Progression Search